

# Science and Survival: Exploring the Papers of Georg and Max Bredig



Scientific Papers and Photographs from the Bredig Archive (Photograph Courtesy of Nathan Raab). Another selection of Immigration Papers from the Bredig Archive illustrates the magazine cover of this Chem Int issue.

by Patrick H. Shea

Following the death of his parents, George Bredig inherited a large steamer trunk inconspicuously tucked away in the basement of his boyhood home in Oak Ridge, Tennessee. The trunk was old, and upon opening it, a strong musty smell emerged from within. As he reviewed the contents of the trunk, he discovered an assortment of unpublished letters, original photographs, rare pamphlets and small scientific artifacts. His father Max and grandfather Georg were both gifted physical chemists and it did not take long for George to realize that these papers documented their scientific careers in the years preceding their flight from Nazi Germany.

The letters numbered in the thousands, written in many different languages and often scattered with scientific formulas that George struggled to understand. As he combed through the collection, he noticed some names appeared more often than others. Names like Wolfgang Ostwald, Jacobus van't Hoff, Svante Arrhenius, Fritz Haber and Ernst Cohen. These were the leading figures in the European physical chemistry community at

the turn of the century, and George's father and grandfather were in the middle of all of it.

Initially, George was unsure what to do with such a trove, but he would later find inspiration in an emotional letter written by Georg to his son in 1937. With the threat of the Nazis confiscating and destroying such a collection, Georg wrote,

"Yesterday, I sent you volumes I-III of my "Opera Omnia" [complete works] as a package of value... However, my reference library here still contains more interesting letters, including those from van't Hoff and Willstätter... It's very important to me that both copies remain in good hands after my death, as they contain information that could be useful for a necrology. If you cannot keep them, please place them in a university library, preferably a foreign one, or with a trusted friend. I do not want them to be wasted, destroyed, or disposed of under any circumstances. I want my life's work to be available for future reference."

His grandfather's instructions were clear and after taking some time to connect with the items on a very

personal level, George set out to find a new home for the collection. With the assistance of Nathan Raab, a Philadelphia area manuscript dealer, that home was found at the Science History Institute.

After years of effort by the Institute's library staff, the collection is now physically accessible in their Philadelphia headquarters and digitally accessible anywhere in the world: see <https://digital.sciencehistory.org/collections/qfih5hl>.

Each digital file can be viewed in granular detail online or downloaded in high resolution, complete with transcriptions and English translations of the German text.

With work complete, the true extent of the collection has revealed itself. It consists of the physical chemistry library and personal archives of Georg Bredig and his son Max during the first half of the 20<sup>th</sup> century. Prior to 1933, the collection reveals the Bredig's place in a vast network of scientific collaboration and international cooperation. After 1933, however, the contents of the collection take a dramatic shift in tone, as those very same scientific networks were employed to support a desperate flight from Nazi occupied Europe.

The central figure of the story is Georg Bredig, who was born in 1868 to a German Jewish family. He began his university education in 1886, first in Freiburg and soon after in Berlin, where he studied chemistry and physics. In Berlin, Bredig became enamored with the, *Zeitschrift für Physikalische Chemie* (*Journal of Physical Chemistry*), which had been founded that very year by the famed chemists Wilhelm Ostwald and Jacobus van't Hoff.

Bredig was so enthusiastic about this new border science that he transferred to the University of Leipzig to study directly under Ostwald, whose Physical-Chemical Institute was considered one of the best in the field. Bredig excelled in his studies at Leipzig, eventually earning the coveted spot of Ostwald's student assistant.

Bredig earned his doctorate "summa cum laude" in 1894 and spent the next 18 months studying physical chemistry with some of the leaders in the field including, Marcellin Berthelot in Paris, Svante Arrhenius in Stockholm, and Jacobus van't Hoff in Amsterdam. While in Amsterdam, Bredig also forged a lasting friendship with one of van't Hoff's most devoted pupils, Ernst Julius Cohen.

Cohen obtained his doctorate in chemistry under van't Hoff in 1893, and soon found a close friend in Bredig. The two collaborated on research related to the transition elements and many other topics concerning the chemistry of photography.



Portrait of Georg Bredig (1868-1944) (photo courtesy of Science History Institute, <https://digital.sciencehistory.org/works/elyhs6i>)

After completing his post-doctoral studies abroad, Bredig returned to Leipzig to work as the Assistant to Ostwald. In this role, Bredig produced a series of pioneering works on colloidal metals and their catalytic properties. Most notably, he developed a method for the preparation of colloidal solutions by use of an electric arc. He expanded on this work by studying and comparing the activity of metal colloids and that of inorganic ferments, which he summarized as his habilitation thesis in 1901. These successes led to Bredig's appointment as the first professor of physical chemistry at the University of Heidelberg. Here, he continued to develop his research from Leipzig and most notably achieved the first catalytic synthesis of asymmetric carbon compounds.

While in Heidelberg, Georg married Rosa Frankel. Together they had two children; a son named Max Albert, born in 1902, and a daughter Marianne, born a year later. In 1910 Bredig moved his family to Switzerland where he had accepted a professorship in the Physical Chemistry Laboratory at the ETH Zurich, but he left soon after to succeed Fritz Haber as Director of the Institute of Physical Chemistry at the Technical University of Karlsruhe in 1911. He would remain in that role for the next 22 years.

Among Bredig's students in Karlsruhe was the Hungarian, Elizabeth Rona, who would go on to become a renowned nuclear chemist, training under one of Bredig's best pupils, Kasimir Fajans. Rona described



Laboratory at the University of Amsterdam, 1894. "Wehmann", Geertruida Wilhelmina Petronella van Maarseveen, Ernst J. Cohen, "Philipps", "Groshans", "Moor", Willem P. Jorissen, "Braskamp", Georg Bredig, and Viktor Rothmund. (photo courtesy of Science History Institute, <https://digital.sciencehistory.org/works/22n5jw1>)

Bredig as, "very much the authoritative German professor" who was known as "Bredig the Terrible" by his students. But she added that, "under his surface sternness and aloofness, Bredig was a warm and sensitive person devoted to his students' welfare."

World War I halted research in Bredig's lab as both funding and personnel became scarce. Bredig, a staunch pacifist, spent the war as a university administrator and volunteer for the Red Cross. The First World War, however, would come to be known as "the Chemist's War" and despite not directly contributing to the German war machine, Bredig's international reputation was tarnished by the sins of his colleagues.

Not only did Germany dominate the chemical industry at the time, but Germany's chemical warfare program was headed by many of its most esteemed chemists, including Fritz Haber. The use of chlorine gas by the German army at the Second Battle of Ypres in 1915 marked a major turning point in the history of warfare as many felt that the Germans had crossed a moral line. Haber had even personally supervised the first successful gas attack at Ypres. Because of this, German and Austrian chemists were ostracized from the

international chemical community after the war. Bredig felt that isolation at his own Institute, which had far fewer international students than were present before the war. That fact weighed heavily on him.

Research collaboration allows scientists to cross both disciplinary and geographic borders. More importantly, it fosters greater knowledge, trust and understanding among the participants. No one understood that fact more than Ernst Cohen who had come to earn a reputation as someone committed to both organizational activities and international cooperation in the chemical community.

When war broke-up that community, Cohen was in a unique position to make a meaningful attempt to restore relations between chemists of recently hostile nations. To this end, he organized a great reunion of chemists in Utrecht in June 1922.\*

Physical chemists from across Europe and the U.S. participated, with the notable exceptions of the French and Belgians who boycotted the meeting. Many German chemists did attend, however, including Bredig, who was eager to take an important step in repairing international scientific friendships and cooperation. For

1. A group photograph of this major reunion, clearly identifying about 50 participants, is part of the archival collection (<https://digital.sciencehistory.org/works/tnrlxmx>). An autographed dinner menu from the following day, 22 July 1922, is also part of the archival collection (<https://digital.sciencehistory.org/works/17mioc8>).



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Black and white photograph of scientists standing in a laboratory in Leipzig, Germany. (circa 1895-1896) The group of men, many of whom are graduate students studying under Wilhelm Ostwald (1853-1932), surround a table crowded with laboratory equipment, tools, and apparatuses. The scientists pictured from left to right have been identified as Julius Tafel (1862-1918), Georg Bredig (1868-1944), Karl Alfred von Zittel (1839-1904), Arthur Rindell (1852-1936), Ostwald, Robert Thomas Diedrich Luther (1868-1945), and, seated in the foreground, Eduard von Stackelberg (1867-1943). <https://digital.sciencehistory.org/works/sdpfe6q>. Courtesy of Science History Institute

Cohen, it was an important step in his own pursuit to become the third President of the International Union of Pure and Applied Chemistry in 1925.\*\*

Bredig's pacifist beliefs and promotion of international cooperation endeared him to many in Europe's scientific community, but it also made him a target of nationalist and anti-Semitic attacks in his own country. When the National Socialists seized power in 1933, these attacks only intensified. In one case, one of Bredig's employees wrote to the Ministry of Education and demanded Bredig's immediate resignation to, "put an end to the internationalization and socialization at German Universities." Then, the Nazi government passed the Law for the Restoration of the Professional Civil Service, which, with some short-lived exceptions, banned all Jews from teaching at German Universities. Without fanfare, Bredig was retired on October 1, 1933. A short time later, Bredig received another terrible blow, the death of his wife.

Georg was a proud German and was convinced that the growing indignities imposed by the Nazi regime were only temporary. He refused calls from family and friends to emigrate, but to his son Max, he gave an ominous warning, "My generation is sinking. Now you all must fend for yourselves!"

As a boy Max showed an aptitude for chemistry and decided to follow in his father's footsteps. He attended

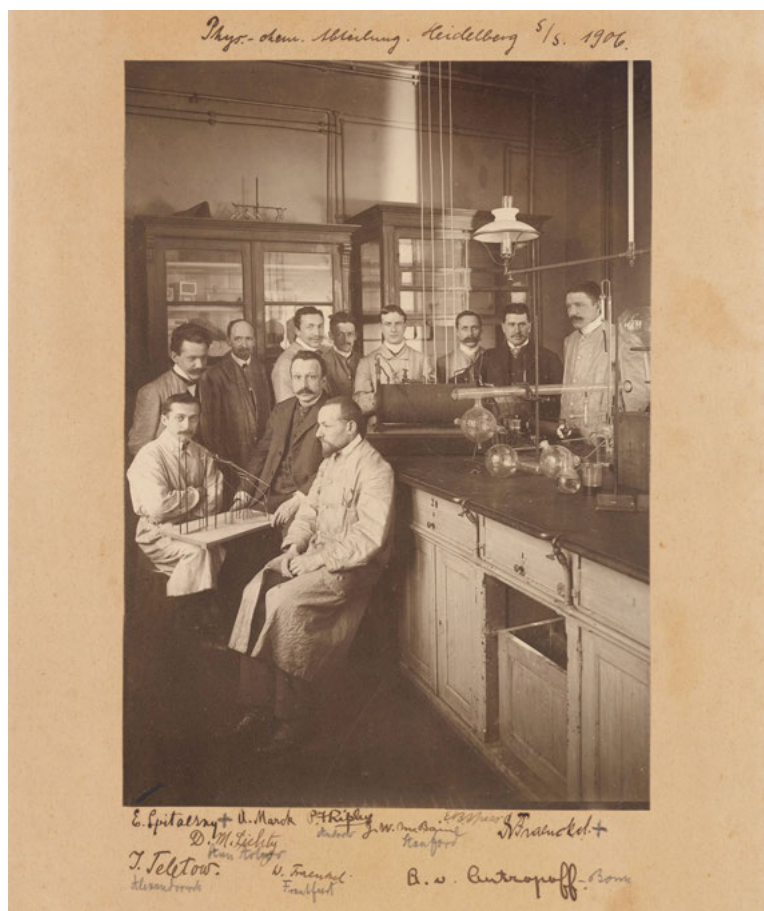
the Technical University in Karlsruhe as an undergraduate, and then moved to the Kaiser Wilhelm Institute in Berlin where he received his doctorate under the direction of Fritz Haber.

Max obtained employment as a research chemist at the Bavarian Nitrogen Works, but when the firm was Aryanized his continued employment was not possible. Max took seriously the warning from his father and fled Germany in 1937.

Staying with colleagues along the way, he travelled first to Sweden, and then to England, before finally arriving at the University of Michigan where he had accepted a fellowship to work in the Department of Chemical and Metallurgical Engineering. That fellowship was arranged by his father's pupil, Kasimir Fajans, who himself had immigrated just a year earlier.

Back in Germany, every day seemed to bring new regulations that restricted some aspect of Jewish life. Then during the events of *Kristallnacht*, a pogrom perpetrated against German Jews in 1938, Georg and about 500 other Jews in the city were arrested, beaten, and publicly humiliated. These events convinced Georg that living out the rest of his years in Germany was not going to be possible. Bredig was not free to move without a moving permit, but was still being forced to give up his home, leaving his fate uncertain. Overwhelmed and desperate, he wrote to

\*\* See also Jorrit P. Smit, "Ernst Cohen and the Challenge of a Truly International Union" *Chem. Int.* 41(3), 2019, pp. 9-10, <https://doi.org/10.1515/ci-2019-0304> and refs therein, and Geert Somsen, "Reconciling Science and Foreign Relations in The Hague" *Chem. Int.* 45(3), 2023, pp. 16-18. <https://doi.org/10.1515/ci-2023-0304>.



Black and white photograph of scientists posing in a physical chemistry laboratory at the University of Heidelberg. On the right side table are several glass flasks, beakers, and columns. Georg Bredig (1868-1944) has handwritten the names of the pictured scientists and their locations beneath the photo. The scientists identified in this caption are E. Spitaler, A. Marck, P. T. Ripley, James William MacBain (1882-1953), Ellwood B. Spear (-1943), S. Fraenckel, David M. Lichty, Iwan Serhijowitsch Teletow (1878-1947), W. Fraenkel, and Andreas von Antropoff (1878-1956).  
<https://digital.sciencehistory.org/works/aysrqhn>



Autographed portrait of Ernst Cohen (1869-1944), circa 1900. In 1902, the Dutch scientist became Jacobus van't Hoff's assistant and a professor at the University of Utrecht. He was IUPAC 3rd President from 1926 to 1928 and chaired the IUPAC Congress in The Hague in July 1928. In 1933, like many Jewish scientists and academics, his career was cut short by growing restrictions of Jews in Nazi Germany. In 1944, he was killed at Auschwitz concentration camp. Courtesy of Science History Institute,  
<https://digital.sciencehistory.org/works/s2oya9v>

Max, "How we will overcome the extraordinary difficulties of the present time is still doubtful. Will our departure even be possible in today's vast crisis?... Life is so hard these days!"

Georg would find a lifeline from his old friend, Ernst Cohen who sponsored and financially supported his immigration to the Netherlands. Certain that the Nazis would destroy his prized library and archive Bredig packed as much as he could and arrived safely in Amsterdam in November 1939.

Although safe for the time being, the Nazi threat still loomed, and Georg's hardships persisted, writing to Max, "I'm still with my friend Ernst in Utrecht and he's trying to make my difficult life as an emigre easier. I'm still healthy. However, it is uncertain if I will survive here until June 1940... Ernst now lives in cramped

conditions and his wife is suffering. Both sacrifice a lot to help me." Max replied with an optimistic note from America, "Even though threats still loom on the horizon, your onward journey seems within reach."

Max knew finding a job for his father in America would improve his father's immigration status, but Georg was approaching the end of his career and academic jobs were proving hard to come by. With the assistance of Hugh S. Taylor, Chair of Princeton University's Chemistry Department, Max devised a way around that problem. Princeton would offer Georg the position of Research Associate on the condition that any payments he received from the appointment would be provided by outside sources and not the University. Max agreed to pay the cost personally, upon which university President Harold Dodds



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submitted the necessary paperwork to the American consulate to expedite Georg's immigration on a non-quota visa. Cohen and fellow chemist H.R. Kruyt in Amsterdam assisted as well, submitting paperwork attesting to the fact that Georg was indeed still an active chemist.

Max sent word of the good news and assured his father,

"Please, don't worry about your potential or financial matters. You don't even need to live in Princeton. You will be here with me [in New York City], and you may occasionally be invited to a discussion with your colleagues working on catalysis or in your other specialties. You also don't have to fear language difficulties if there should be such a discussion. Taylor speaks German fluently and I will probably accompany you. In any case, these things don't matter. They know very well who they are dealing with. Taylor worked with Bodenstein for a long time. He even remembers you personally

and thought that I resembled you! Moreover, at first, you will have some time to rest, if you have not done so under the good care of the Cohens."

Georg, thrilled to receive the appointment, sent his reply to the president of Princeton in a wonderfully short and succinct telegram in December 1939, which read, "highly honored. Accept. Coming as soon as possible." He arrived in the United States just months later, leaving behind a portion of his scientific library in the van't Hoff laboratory for the remainder of the war.

The Nazi war machine rolled into Amsterdam just five months after Bredig's departure, and Cohen, who was also Jewish, would quickly transition from savior to victim. Cohen experienced many of the same indignities and restrictions as Georg had in Germany, but Nazi policies were becoming increasingly vicious. By 1942 the regime abandoned plans to forcefully migrate Jews from Europe in favor of the "final solution," which was to murder all Jews within reach. Cohen met his fate two years later, when on February 28, 1944, he was arrested on trumped-up charges. A few days later he was deported to Auschwitz where he was gassed on March 6. History would not overlook the bitter and cruel irony surrounding the events of his death.

Georg never quite regained his strength after immigrating to America and would never take up his passion for physical chemistry again. He lived his remaining days with Max in New York, dying on April 24, 1944.

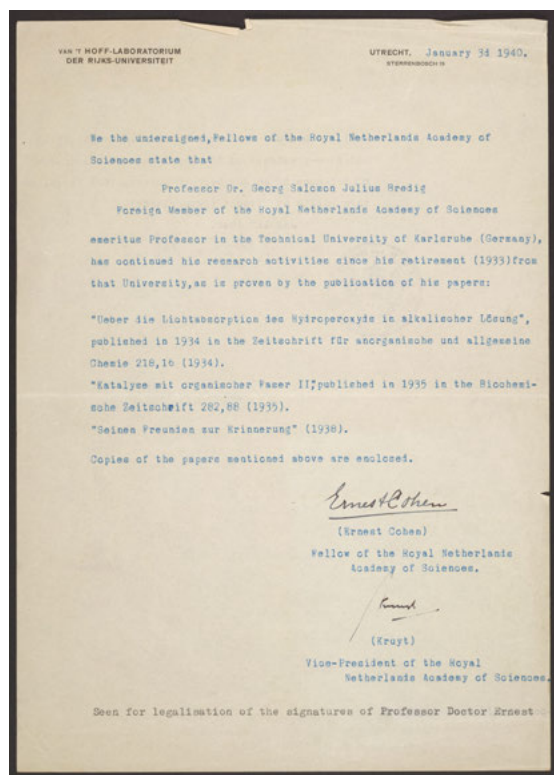
Max continued focusing his efforts to assist his sister's family and many other former colleagues out of Europe. He had several successes, including chemists Alfred Reis and Fritz Hochwald whom he assisted with money, affidavits of support, and in some cases employment. Max also had some tragic losses.



Max Bredig's German Passport, 1937. (photo courtesy of Science History Institute, photo page from <https://digital.sciencehistory.org/works/8r00347>)



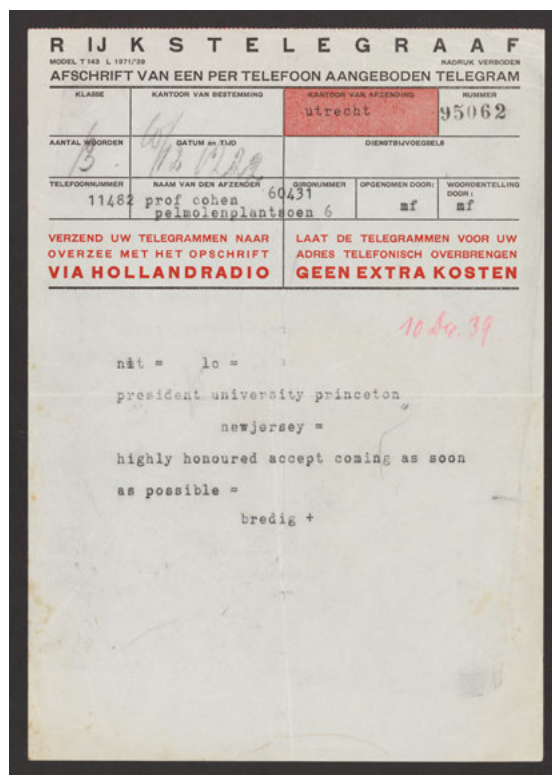
German Identification Card, 1938. As mandated by Nazi Law, Georg was forced to adopt the “Jewish” name, Solomon Julius Georg Bredig. (Science History Institute Archives) page from <https://digital.sciencehistory.org/works/925q57t>



Statement from the Fellows of the Royal Netherlands Academy of Sciences regarding Georg Bredig's research activities from 1933-1940. This statement was needed to help Bredig immigrate to the United States. Courtesy of Science History Institute <https://digital.sciencehistory.org/works/ml2d1fx>

By 1938 Max's former colleague Alfred Schnell, and his new bride Eva, had fled Nazi Germany to take up residency in The Hague. After the German invasion of the Netherlands, they were ordered to report to a Nazi transit camp. Instead, they went into hiding with the assistance of the Dutch resistance. They found refuge on a farm in Oldebroek, about 40 miles east of Amsterdam, with a widow named Hendrikje Blaauw-Flier. They slept each night underground, in a small hiding space beneath a haystack. Incredibly, while in hiding they sent short messages to Max via the Red Cross. Often writing in code and using aliases to protect their identities, these letters were their only lifeline to the outside world.

In autumn 1944 Max lost contact with the Schnells. According to eyewitness accounts, they were discovered in their hideout by German soldiers during a raid of the surrounding area and taken to a nearby town for interrogation. They were to be kept overnight and transported the following morning to Poland. But that night, a pair of Dutch Nazis took Eva and Alfred from their cells, along with four other prisoners. They were taken to a



On 10 December 1939, Georg Bredig writes to Princeton University President, Harold Willis Dodds, to accept a Research Associate position at Princeton University. Bredig's acceptance of this position allows him to immigrate to the United States. (photo courtesy of Science History Institute, <https://digital.sciencehistory.org/works/dq1vcry>)

park and told to dig six holes. When Eva protested, she was shot. The rest were murdered immediately after.

The consequences of war and the Holocaust weighed heavily on Max. After the war he made a point of distinguishing between former German colleagues he felt were culpable and those he felt worthy of praise. When the *Journal of Chemical Education* published a letter praising the career of Wolfgang Ostwald, Max felt compelled to set the record straight on the son of his father's mentor.

In his own letter to the editor, Max bluntly stated,

"A considerable number of former European Scientists... remember vividly the swastika which Ostwald used to wear, cautiously on the inside of his lapel before 1933, but proudly in the open in the days of the Hitler regime... Wo. Ostwald was a very good Nazi... Death indeed saved this clever, double-talking propagandist... He was the son of the greater Wilhelm Ostwald who was held in reverent memory by [my] own father not only as an admired teacher and personal friend but – in contrast to the



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Max Bredig (1902-1977) seated at a desk in an office at the University of Michigan. Max emigrated from Germany to the United States with the assistance of Kasimir Fajans (1887-1975) to avoid further persecution under the Third Reich and to begin a postdoctoral fellowship at the University of Michigan. (photo courtesy of Science History Institute, <https://digital.science-history.org/works/8qew1rb>)

son- for the honesty which he strove to advance true international understanding and cooperation.”

Other German Chemists, particularly Karl-Friedrich Bonhoeffer, received Max’s praise and admiration after the war. When Nobel-Prize-winning chemist Harold Urey circulated a letter among Bonhoeffer’s colleagues in America to raise money on Bonhoeffer’s behalf, more than 50 scientists including Max and Kasimir Fajans answered the call. Max knew Bonhoeffer from his days at the Kaiser Wilhelm Institute in Berlin and was familiar with his illustrious family. Karl’s younger brother, Dietrich was an influential pastor, theologian and anti-Nazi dissident. In the closing days of the war, Dietrich and his

other brother Klaus, were both executed for their part in the July 1944 plot to assassinate Hitler. Karl developed heart trouble after the war, and Urey’s letter helped raise over \$1,000 to enable three months’ rest in Switzerland.

Max reunited with many other former colleagues who had also found their way to America during the European “brain drain” of World War II. The Hungarian-born theoretical physicist, Eugene Wigner, was Max’s senior at the Kaiser Wilhelm Institute, and when he became the director of research and development at Oak Ridge National Laboratory in 1946, he brought Max on to establish an x-ray diffraction laboratory. Max remained at Oak Ridge until 1967 when he retired as Assistant Director of the Chemistry Division.

Max may not be as well remembered as his father or some of his more famous colleagues, but he was without question a first-rate scientist. He published almost 100 scientific papers and is probably best known in the field for his work on the interaction of molten metallic halides with their metals. To this day, the Max Bredig Award is given out by the Electrochemical Society.

Still, few people know about the work Max undertook during the war. Even to his son George, Max rarely spoke of the hardships he endured during the Nazi regime or his efforts to save his father and former colleagues from a horrific fate. It was only after the contents of this archive surfaced that the true extent of the Bredig story has finally been revealed; one of science and survival. 🏠



In 2001 a monument in Zwolle, Netherlands was unveiled honoring the six people murdered on the evening of October 3, 1944.

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