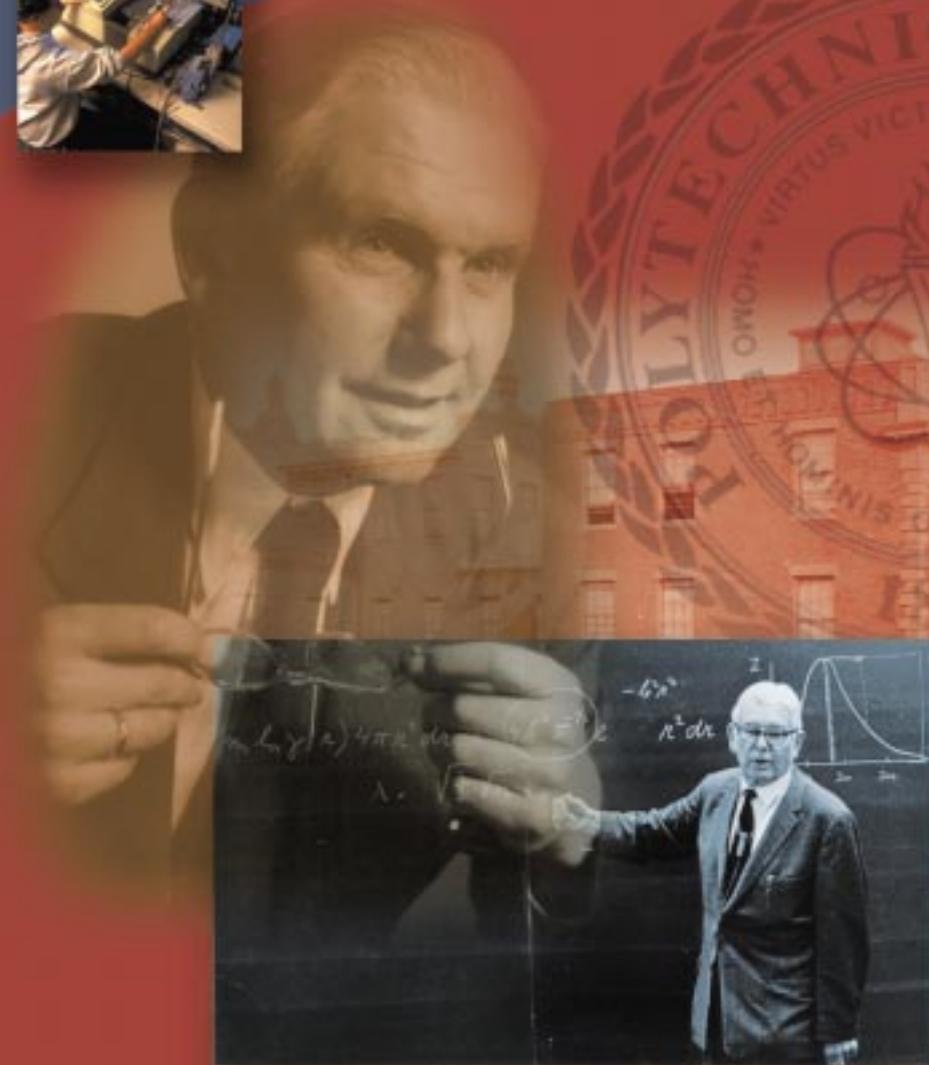


Historic Chemical Landmark

A National Historic Chemical Landmark



“Polymer education has grown from a seed at
“Brooklyn Poly” to a young giant redwood...”

— C.E. Carraher, “Polymer Education and the Mark Connection,” in G. Allan Stahl, ed., *Polymer Science Overview: A Tribute To Herman F. Mark* (Washington, D.C. American Chemical Society, 1981), p. 142.

polymer

Celebrating Chemistry

The American Chemical Society designated the Polymer Research Institute a National Historic Chemical Landmark on September 3, 2003. For additional information see our Web site: www.chemistry.org/landmarks.

Polymer Research Institute

Herman Mark (1895-1992) arrived at Polytechnic Institute (now University) in Brooklyn, New York, in 1940. A prominent scientist and a pioneer in the study of polymers, he immediately began putting together a curriculum for the teaching of polymer chemistry.

In addition to teaching an introductory course in polymer chemistry, Mark organized a Saturday morning symposia series at which leading scientists spoke. These were widely attended, exposed students at the school to the latest in polymer research, and served over the years to give polymer education at Brooklyn Polytechnic international recognition. Mark also organized intensive summer courses for the study of macromolecular science to which he invited outside university scholars and industrial researchers.

In effect, a polymer institute was being created *ad hoc* at the Polytechnic Institute. That was the situation when in 1946, as Mark relates in his autobiography, Dean Raymond Kirk took Mark into President Harry Rogers office and said “Why don’t we simply give a name to something that has grown upon us? Let us call it our Institute of Polymer Research.” The Institute would be staffed with the school’s professors, the equipment was already in place, and, Mark said, in essence they would continue to do what they were doing, just giving it a new name. The only cost would be a new letterhead with “Polymer Research Institute” on it.

Under Mark’s active leadership, the Polymer Research Institute, or PRI, grew and attracted many first

class scientists to its facilities in a converted razor blade factory. Mark made PRI a magnet for anyone in the United States who wanted to study or teach polymer chemistry. Polytech attracted students and postdoctoral fellows from all over the world, including Great Britain, India, France, Israel, Italy, Japan, and the Soviet Union. Among those who came to study, teach, or do postdoctorals were Turner Alfrey, Herbert Morawetz, Charles Overberger, Gerald Oster, Murray Goodman, Paul Doty, Bruno Zimm, Frederick Eirich, Robert Simha, Arthur Tobolsky, and Eli Pearce. PRI educated undergraduates and graduate students, granting M.S. and Ph.D. degrees in polymer chemistry.

Mark’s work, and the presence of the Polymer Research Institute, helped make polymer chemistry an important scientific discipline. When Mark began the Institute, there were only a handful of chemists working with synthetic polymers at U.S. universities: among them were such important scientists as Carl “Speed” Marvel and Paul Flory. But none succeeded in creating a facility like the Polymer Research Institute.

As Mark said in an interview in 1986, “we [PRI] had our peak in the late fifties and early sixties. Then many of our best professors went other places and we shrank.” But PRI remained influential, as other universities, including Illinois, where the impact of Marvel was strong, Case Western Reserve, Massachusetts, North Carolina State and Akron, instituted polymer institutes. In industry, where DuPont had dominated the field, now Dow, Phillips Petroleum, Rohm and Haas, Shell, and the major rubber manufacturers

developed polymer programs. Many were started by scientists who had studied or taught at PRI and all were influenced by the work of Herman Mark in establishing polymer chemistry in the United States.

Polymer Chemistry

Polymers are substances made of giant molecules formed by uniting simple molecules or monomers by covalent bonds. The word comes from Greek and it means many parts. Polymers have high molecular weights, which gives them useful physical characteristics such as high viscosity, elasticity, and great strength. Polymers are found everywhere. They are part of man himself: proteins and nucleic acids are polymers. Natural fibers such as wool and cotton are polymers. And of course many synthetics, such as plastics, nylon, and man-made rubber, are polymers.

Today, the existence of polymers is readily accepted in the scientific world, and polymer science is a vital branch of chemistry. But that acceptance is fairly recent. As late as the early years of the 20th century, many of the most prominent chemists resisted the concept of macromolecules with molecular weights of thousands and even millions.

In 1920, Hermann Staudinger theorized the existence of very long chains with molecular weights reaching hundreds of thousands. He also claimed these chains were held together by normal covalent bonds. Staudinger, who won the Nobel Prize in Chemistry in 1953, coined the term macromolecules to refer to this phenomenon.

In the 1920s and 1930s Herman Mark clashed with Staudinger because Mark doubted Staudinger's view that macromolecules were long, thin rigid rods. Mark argued that long chain molecules rotated around covalent bonds.

Although Mark and Staudinger disagreed on the nature of macromolecules, they did agree on their existence. Their work helped the polymer concept gain acceptance in the scientific community. Another important influence came from the work of Wallace Carothers, whose investigations at DuPont demonstrated that polymers, made up of hundreds of covalently joined monomers, could be synthesized. This work led to the introduction of the first synthetic fiber, nylon, in the 1930s.

Herman Mark

Herman Mark was born in Vienna in 1895, the son of a Jew who converted to Lutheranism upon marriage. After his education at the University of Vienna, Mark joined the newly organized Institute for Fiber Research, founded within the Kaiser Wilhelm Institute, in Germany. Mark worked on the molecular structure of fibers using the new tools of X-ray diffraction and ultramicroscopy.

In 1926 Mark took a position at I.G. Farben, which had begun to stress the manufacture of cellulose acetate and viscose and to investigate the production of synthetic fibers. In 1932 he was summoned to the office of the plant's managing director, who said to him that since Hitler would soon take power in Germany, his position as a foreigner and the son of a Jewish father made him vulnerable. The official suggested Mark look for another job outside of Germany.

Mark heeded the advice and took a position as professor of physical chemistry at the University of Vienna, where he designed a curriculum in polymer chemistry. His years in

Vienna proved to be an important prelude for the later Polymer Research Institute.

Austria was only a temporary haven from the Nazis for Mark. By early 1938, he began preparing to leave Austria by clandestinely buying platinum wire, which he bent into coat hangers while his wife knitted covers so that the hangers could be taken out of the country. Mark's son Hans estimates that the value of the platinum was roughly \$50,000, a lot of money in the 1930s. Mark initially fled to Canada before accepting an offer to become adjunct professor at the Polytechnic Institute.

It is a sign of Mark's temperament and personality that he held little anger or contempt for those who forced him to leave Europe. He would describe the Nazis as "misguided" and scientists who supported them as "unfortunate." But he bore few if any grudges and he was active immediately after the Second World War in reintegrating German and Austrian scientists into the world scientific community. He told his son Hans that "I went through a war that we lost, the Austrians lost, and I can't be a believer in collective guilt."

Early in Herman Mark's tenure in Brooklyn, his colleague Isidor Fankuchen addressed Mark as *Der Geheimrat*, which means privy or secret councilor, but in German universities it had a special, untranslatable meaning that suggests the standard caricature of the "stuffed shirt," pompous professor. Fankuchen meant *Geheimrat* as a joke, but it stuck as a title for Mark precisely because he was the antithesis of a true *Geheimrat*. Mark, who had a self-deprecating sense of humor, was pleased by the title, and he became known as the *Geheimrat*.

Known as the *Geheimrat*, but hardly a *Geheimrat*, Mark was Viennese to the core, the kind of central European who kissed lady's hands. Murray

Herman Mark



Goodman, who taught at PRI, describes Mark as "a combination of a European and Viennese gentleman, with the openness to people, places and ideas which are really typically American." According to another colleague, Eli Pearce, Mark was "formal in an informal way." Associates invariably have kind words for Mark. Herbert Morawetz, who came to Brooklyn Polytech as a student and joined the faculty in 1951, describes Mark "as a man of tremendous personal charm."

By the time Mark came to America and organized the Polymer Research Institute, he had already done much of his important, creative, and seminal research. His contributions to science now were as an ambassador for polymer chemistry. He did this in many ways: through the symposia he organized at the Institute; by lecturing all over the world; by having a hand in polymer publications; and by keeping up with the latest research. According to Murray Goodman, Mark had "a special ability to know what was going on, to be at the center, and to know what breakthroughs were imminent and to communicate that widely and broadly through the scientific world."

National Historic Chemical Landmark

The American Chemical Society designated the Polymer Research Institute a National Historic Chemical Landmark on September 3, 2003. The plaque commemorating the event reads:

The Polymer Research Institute was established in 1946 by Herman F. Mark, a pioneer in the study of giant molecules. The Institute brought together a number of polymer researchers to create the first academic facility in the United States devoted to the study and teaching of polymer science. Scientists associated with it later went on to establish polymer programs at other universities and institutions, contributing significantly to the development and growth of what has become a vital branch of chemistry, engineering, and materials science.

About the National Historic Chemical Landmarks Program

The American Chemical Society, the world's largest scientific society with more than 161,000 members, has designated landmarks in the history of chemistry for more than a decade. The process begins at the local level. Members identify milestones in their cities or regions, document their importance, and nominate them for landmark designation. An international committee of chemists, chemical engineers, museum curators, and historians evaluates each nomination. For more information, please call the Office of Communications at 202-872-6274 or 800-227-5558, e-mail us at nhclp@acs.org, or visit our web site: www.chemistry.org/landmarks.

A nonprofit organization, the American Chemical Society publishes scientific journals and databases, convenes major research conferences, and provides educational, science policy, and career programs in chemistry. Its main offices are in Washington, DC, and Columbus, Ohio.

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