



Herman Mark, "The Geheimrat", at 90

If it can be said of any man that he has become legendary in his lifetime, this is certainly so with Professor Herman Mark, whose 90th birthday will be celebrated on May 3. Having been one of the originators of polymer science almost 60 years ago, he has not only made numerous crucial contributions to his chosen field, but he has had, through all these years, a pervasive influence on the polymer community in all corners of the earth. His versatility has been astounding: Unlike many other first-rate scientists, he has not limited himself to academic research, but has had a profound impact as an industrial research director during the era which saw the first successes of a polymer industry, and has continued to exercise, as a consultant, an important influence on the phenomenal growth of that industry over the past half century. Many government agencies have benefited from his advice. His brilliant teaching has inspired not only his students, but countless others who were stimulated by his lectures. His organizational effectiveness has led to the foundation of journals, monograph series, and the publication of a polymer encyclopedia, which accelerated the establishment of the study of polymers as a respected branch of scientific endeavor. Equally important has been his role as an ambassador of the polymer community, organizing contacts between polymer scientists in different countries and encouraging an atmosphere of friendship which has made international polymer symposia particularly enjoyable.

Before Mark became a scientist, his fame rested on very different accomplishments: Before the first world war he was a star of the Austrian soccer team and during that war he became one of the most highly decorated officers of the Austro-Hungarian army. In 1918 he became a prisoner of war in Italy and it was in prison camp that he first concentrated on the study of chemistry. After his return to

Vienna he studied for his doctorate under the direction of W. Schlenk, writing a thesis on the pentaphenylethyl radical. (For those interested in scientific genealogy, it may be noted that Schlenk had been a student of A. Baeyer, who had studied with Liebig and Kekulé.) When Schlenk succeeded to the Berlin professorship which had been held by Emil Fischer, he took Mark with him. One day Schlenk was visited by his friend F. Haber, director of the Kaiser-Wilhelm-Institut, who asked him to recommend a chemist who would be equally at home in physical and organic chemistry. Schlenk had no hesitation in recommending Mark, who had obtained his doctorate in organic chemistry but was obviously fascinated by the recent developments of physicochemical techniques. And so Mark moved early in 1922 to the section of the K.W. institute concerned with fiber research in Berlin Dahlem.

The Dahlem laboratory in the early 1920s was a place with the most unusual concentration of talent. Shortly before Mark's arrival, M. Polanyi had been hired and asked to apply the new science of X-ray crystallography to the study of natural fibers. He quickly infected with his enthusiasm a sizable group of younger men. Reminiscing about this period 40 years later, Polanyi singled out Mark as one "whose experimental skill bordered on genius". While in Dahlem, Mark was little concerned with polymeric materials but concentrated on crystal structure determinations of metals (zinc, tin, and bismuth) and low molecular weight compounds such as ammonia, hexamethylenetetramine, pentaerythritol, triphenylmethane, and oxalic acid. His work on the structure of graphite was important since it provided him with an example of a substance in which the size of a covalently bonded structure bore no relation to the crystallographic unit cell, contrary to the belief held widely at the time that in any

crystal the unit cell has to be larger than the molecule. In 1926 a meeting of the German Society of Natural Scientists and Physicians was held in Düsseldorf, and this was the occasion when Staudinger had to confront a galaxy of respected organic chemists who ridiculed his belief in long-chain molecules. Mark was asked to present the crystallographic evidence, and, although he was not yet ready to provide proof for the chain structure, he was emphatic in stating that a small unit cell cannot be used as an argument against the existence of a much larger covalently bonded species.

In 1927 Mark moved from Dahlem to Ludwigshafen, where he headed for the next 6 years a research laboratory of the IG Farbenindustrie, charged with clarifying the structure of cellulose, starch, rubber, and silk and utilizing this knowledge for the synthesis of technically useful polymeric materials. There exist many testimonials to Mark's effectiveness as a leader during this period, with frequent mention of his informal manner, so unusual in the Germany of those days. Particularly fruitful was his close relation to K. H. Meyer, who found time for detailed collaborations on research projects in spite of his time-consuming duties as director of the company. The Mark-Meyer team succeeded in the first crystal structure determination of chain molecules—cellulose, silk fibroin, *Hevea* rubber, and chitin. Meyer also used his influence to induce the management of the company to allow Mark to pursue some of his scientific interests which could hardly lead to a marketable product. This enabled Mark to carry out pioneering studies of electron diffraction by gases.

By 1932 the political situation in Germany made it obvious that Mark would not be able to remain in Ludwigshafen and Mark was fortunate in that he was offered financial assistance if he would move to an academic position. He accepted a professorship in his native Vienna and created there a leading school of polymer research before the Nazi invasion of 1938 obliged him again to move. One of the memorable achievements of the brief Vienna period was a formulation, with E. Guth, of a theory of rubber elasticity.

In 1937 Mark had been approached by the International Paper Co. with the suggestion that he spend a few months in Hawkesbury, Ont., planning the modernization of the company's research laboratories. This offer came in handy after he was dismissed from his professorship in April 1938. He was briefly interned but managed to leave Austria secretly with his family and reached Canada in September. However, he remained in Hawkesbury less than 2 years,

since he was unwilling to restrict his studies to cellulose.

In May 1940 Mark started his career at the Polytechnic Institute of Brooklyn. He soon established a curriculum in polymer chemistry—the first of its kind. Over the years, graduates of this program have come to occupy a considerable fraction of industrial and academic positions in polymer science. I am sure they remember with affection the most exciting event of the year: When Professor Mark returned from his visits to U.S. and foreign laboratories to report on "What is new in polymers". He had an uncanny intuition for what was going to be important. For instance, he related with enthusiasm Ziegler's initial experiments with alkylaluminum compounds, long before the spectacular discovery of high-density polyethylene.

Mark's long-standing association with E. Proskauer led to the founding of the *Journal of Polymer Science* and to the publication of a "High Polymers" series of monographs by Interscience Publishers. He contributed, with A. Tobolsky, the influential volume "Physical Chemistry of High Polymeric Systems".

Over the years, Professor Mark has been the recipient of an unusually large number of honors. He has been awarded 20 honorary doctorates and is a member of 18 academies of sciences. He has received the National Medal of Science, the Gibbs Medal, the Perkin Medal, the Humboldt Award, and the Wolf Prize in Chemistry, with numerous other distinctions. Yet, all this acclaim has not changed his essential simplicity. Many years ago, I. Fankuchen called him jokingly "Geheimrat" since he could not be more different from the image of the pompous, self-important men who boasted this title. The nickname stuck, and it is as the Geheimrat that he is loved and admired by his many friends all over the world. It is delightful to see that, at an age when most people have long retired from their professional activities, the Geheimrat's involvement with polymers shows no sign of decreasing. He still attends many scientific meetings (and may ask the most incisive question at the end of a lecture), still lectures, manages a vast amount of technical reading, and crosses the ocean back and forth more than a dozen times a year. All his friends wish him a very happy birthday and many years through which he may continue to enjoy undiminished activity.

Herbert Morawetz

*Polytechnic Institute of New York
Brooklyn, New York 11201*