cules (and not aggregates held together by secondary forces) had only recently been established by the work of Staudinger, Carothers and others.

Flory's first paper on polymers dealt with the kinetics, mechanism and molecular-weight distributions to be expected in linear-condensation polymerization. Contrary to the view prevailing at the time, Flory assumed that the normal reactivity of a given functional group is a function of local structure, and not of overall molecular size. This assumption and the application of statistical methods allowed Flory to predict molecular-weight distributions; he later confirmed these predictions in experiments of his own. During this period he also made fundamental contributions to the theory of addition polymerization, introducing the fundamental concept of chain transfer.

A year after Carothers's death in 1937, Flory left DuPont and joined the Basic Science Research Laboratory of the University of Cincinnati, where he remained for two years. At Cincinnati he extended his treatment of condensation polymerization to include monomers with more than one functional group, which give rise to branched structures. Under conditions precisely defined by Flory, the branched structures are transformed into an insoluble, elastic network—a gel. This theory gives an accurate account of gelation in polymers made up of long-chain molecules that can be crosslinked.

Flory then spent eight years in industry, working at Esso (now Exxon) from 1940 to 1943 and at Goodyear from 1943 to 1948. During this period he produced pioneering works on the thermodynamics of polymer solutions, rubber elasticity and the frictional properties of polymers in solution.

In 1948 Flory was invited to give the Baker Lectures at Cornell by Peter Debye, then the chairman of the chemistry department. These lectures formed the basis of his first book, *Principles of Polymer Chemistry* (Cornell U.P., 1953), which today remains a primary introduction to and reference for polymer science. In the autumn of 1948, he joined the chemistry department at Cornell. He remained there until 1956, at which time he became executive director of research at the Mellon Institute in Pittsburgh, now part of Carnegie–Mellon University.

The Cornell period was especially productive for Flory. While there he formulated the now famous smoothed-density model for treating the effect of long-range excluded-volume forces between different parts of a polymer on the chain configuration. In addition, he made fundamental contributions to the theory of the viscosity of polymer solutions and to determining the relations between polymer viscosity and the dimensions of a polymer molecule.

FLORY

Also during this period, he formulated the fundamental concept of what he called "theta conditions," and what others now often call "Flory conditions." These are the conditions under which the long-range excluded-volume forces between two parts of a polymer chain are just canceled out by the polymer–solvent interaction. Studying a polymer under Flory conditions eliminates the effect of long-range forces between the different parts of a polymer chain and emphasizes the short-range forces. Because the long-range forces are "universal" and the short-range forces are what distinguish one polymer from another, one can then compare the properties of different molecules and relate their differences to the structures of the monomer units of which they are made. Other areas in which Flory made fundamental contributions during this period are the swelling of network structures and gelation, the elasticity of rubber and fibrous proteins, and the formation of liquid-crystal phases in solutions of asymmetric molecules.

In 1961, having resigned from the Mellon Institute, Flory moved to Stanford University as a professor of chemistry. His presence there had a profound effect on the development of the new program in chemistry at Stanford in the early 1960s. It was a key element in attracting many eminent chemists to move to Stanford. He was appointed J. G. Jackson–C. J. Wood Professor of Chemistry in 1965, and served as chairman of the department from 1969 to 1971.

At Stanford, one of Flory's major research concerns was the calculation of the configuration of a polymer chain from the potential energies of the units making up the chain, generally using data obtained by molecular spectroscopists on small molecules (often in the gas phase). These techniques were successfully applied by Flory and his students to a wide range of synthetic and natural polymers. His second book, *Statistical Properties of Chain Molecules* (Interscience, 1969), deals extensively with this work. Flory extended this work, which applies to single polymer chains, to bulk liquid polymers and amorphous polymer solids. At Stanford, he made in addition important contributions to the theories of the structure of semicrystalline polymers, the formation of liquid crystals and the structure of detergent micelles and membrane vesicles.

In 1974 Flory received the Nobel Prize in chemistry for developing analytic methods to study properties and molecular structures of long-chain molecules.

Although Flory became an emeritus professor at Stanford in 1975, in no sense of the word did he "retire." He made some of his most important contributions in the 10 years after his "retirement." He maintained two vigorous research groups: one at Stanford and another at the IBM Research Laboratories in San Jose, California. At the time of his death he was at Big Sur preparing a paper to be delivered at a meeting of the American Chemical Society. In commemoration of his 75th birthday last June, Stanford University Press published a three-volume set of his selected works.

In addition to his direct scientific contributions, Flory was one of the leaders in the struggle for human rights for scientists living under totalitarian regimes, especially the Soviet Union. He was a founder of and the principal spokesman for the groups that came to be known as Scientists for Sakharov, Orlov and Shcharansky and the Union of Concerned Scientists.

With his passing the world has lost a giant of science and a fine human being. We shall all miss him very much.

ROBERT PECORA
Stanford University
Palo Alto, California

Robert Bigham Brode

Robert Bigham Brode, professor of physics emeritus at the University of California, Berkeley, died 19 February 1986.

Born in Walla Walla, Washington, on 12 June 1900, Brode graduated from Whitman College in 1921 and received a PhD in physics from Caltech in 1924.

He began his professional career as an associate physicist with the National Bureau of Standards, followed by a Rhodes scholarship at Oxford in 1924–25. He was a National Research Fellow in Göttingen in 1925–26 and at Prince-

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BRODE

ton University in 1926–27.

Brode was appointed assistant professor of physics at the University of California at Berkeley in 1927, and rose to the rank of full professor in 1932—the fastest advance in the history of the department of physics. His initial research work was in atomic physics but he soon shifted to cosmic-ray investigations similar to those then under way in European laboratories, particularly those of Louis Leprince-Ringuet and Pierre Auger in Paris.

Brode spent 1934–35 as a Guggenheim Fellow at Cambridge University and the University of London. On his return he worked with Ernest Lawrence, J. Robert Oppenheimer, Robert Birge and other members of the Berkeley faculty in developing a world-quality physics department.

Shortly after the beginning of World War II, Brode was asked to direct the work, conducted at what is now Johns Hopkins Applied Physics Laboratory, that led to the proximity fuse.

In 1943 Oppenheimer asked him to join the Manhattan Project as one of the senior group leaders. Brode's work on the atom bomb, only recently declassified, involved applying his proximity-fuse work to meet the extremely high reliability requirements of the atomic bomb.

Returning to Berkeley in 1946, Brode resumed his teaching and research. In particular, he investigated the intensity and masses of cosmic-ray particles using a large cloud chamber in a magnetic field. He also used cloud chambers in a magnetic field in a B-29 aircraft to observe cosmic rays at an altitude of 30 000 feet. He became involved in administrative work as well, and as a member of the academic senate's budget committee for several years, he assisted in moving Berkeley into the first rank of American universities. He was a Fulbright Fellow in Manchester, England, in 1951–52.

Brode was acting director of Berkeley's Space Sciences Laboratory in 1964–65 and thereafter spent two years in London as the director of the university's education-abroad program in the United Kingdom. He retired in 1967 but continued as an academic adviser on the university's system-wide staff.

William Fretter
University of California
Berkeley, California

Shirley Leon Quimby

Shirley Leon Quimby died on 15 May 1986 at the age of 93. Quimby taught physics at Columbia University from 1919 to 1962, when he retired and became professor emeritus. He was treasurer of The American Physical Society from 1957 to 1970, and APS treasurer emeritus since 1970. When Quimby took over as treasurer the society had one employee, and there was no satisfactory bookkeeping or accounting system. Quimby effected the transition from a back-of-the-envelope operation to a reasonably conventional system more befitting the growth in size and membership that has occurred since World War II.

Quimby was born 21 August 1893 in San Francisco. He studied philosophy as an undergraduate at the University of California at Berkeley, after which he served in the US Navy during World War I. Assigned to the New London base, Quimby impressed Albert Wills, who was the officer in charge of research on antisubmarine devices. After the war Wills returned to his post as professor of physics at Columbia and convinced Quimby to become a graduate student there, where they worked together in solid-state physics. Quimby received a PhD in physics in 1925 and immediately joined the faculty at Columbia. During World War II he returned to the Navy, where he helped develop anti-magnetic-mine devices.

Quimby was an outstanding experimenter. He pioneered the use of quartz crystals to make precise measurements of elastic constants of solids. In his early work at Columbia Quimby developed the "composite oscillator," a device consisting of a piezoelectric quartz crystal serving as an ultrasonic driver cemented to a second crystal that was to be studied. He showed that from the resonant frequency of this oscillator one could obtain sound velocities and, therefore, elastic constants with high precision. At the same time, the damping of mechanical loss of the composite oscillator yielded the "internal friction" in the crystal of interest. Together with his students, Quimby used this method to study the elastic constants