Paul Flory Biography

Paul John Flory - Class of 1927 (June 19, 1910 – September 9, 1985, born in Sterling, IL but raised in Elgin, IL) was an American chemist and Nobel laureate who was known for his prodigious volume of work in the field of polymers, or macromolecules. He was a leading pioneer in understanding the behavior of polymers in solution, and won the Nobel Prize in Chemistry in 1974 "for his fundamental achievements, both theoretical and experimental, in the physical chemistry of macromolecules".

Early life - After graduating from Elgin High School in Elgin, Illinois in 1927, Flory received a bachelor's degree from Manchester College (Indiana) in 1931 and a Ph.D. from the Ohio State University in 1934. His first position was at DuPont with Wallace Carothers.

Career and Polymer science

Flory's earliest work in polymer science was in the area of polymerization kinetics at the DuPont Experimental station. In condensation polymerization, he challenged the assumption that the reactivity of the end group decreased as the macromolecule grew, and by arguing that the reactivity was independent of the size, he was able to derive the result that the number of chains present decreased with size exponentially. In addition polymerization, he introduced the important concept of chain transfer to improve the kinetic equations and remove difficulties in understanding the polymer size distribution.

In 1938, after Carothers' death, Flory moved to the Basic Science Research Laboratory at the University of Cincinnati. There he developed a mathematical theory for the polymerization of compounds with more than two functional groups and the theory of polymer networks or gels.

In 1940 he joined the Linden, NJ laboratory of the Standard Oil Development Company where he developed a statistical mechanical theory for polymer mixtures. In 1943 he left to join the research laboratories of Goodyear as head of a group on polymer fundamentals. In the Spring of 1948 Peter Debye, then chairman of the chemistry department at Cornell University, invited Flory to give the annual Baker Lectures. He then was offered a position with the faculty in the Fall of the same year. He was initiated into the Tau Chapter of Alpha Chi Sigma at Cornell in 1949. At Cornell he elaborated and refined his Baker Lectures into his magnum opus, *Principles of Polymer Chemistry* which was published in 1953 by Cornell University Press. This quickly became a standard text for all workers in the field of polymers, and is still widely used to this day.

Flory introduced the concept of excluded volume, coined by Werner Kuhn in 1934, to polymers. Excluded volume refers to the idea that one part of a long chain molecule can not occupy space that is already occupied by another part of the same molecule. Excluded volume causes the ends of a polymer chain in a solution to be further apart (on average) than they would be were there no excluded volume. The recognition that excluded volume was an important factor in analyzing long-chain molecules in solutions provided an important conceptual breakthrough, and led to the explanation of several puzzling experimental results of the day. It also led to the concept of the theta point, the set of conditions at which an experiment can be conducted that causes the excluded volume effect to be neutralized. At the theta point, the chain reverts to ideal chain characteristics - the long-range interactions arising from excluded volume are eliminated, allowing the experimenter to more easily measure short-range features such as structural geometry, bond rotation potentials, and steric interactions between near-neighboring groups.

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Flory correctly identified that the chain dimension in polymer melts would have the size computed for a chain in ideal solution if excluded volume interactions were neutralized by experimenting at the theta point.

Among his accomplishments are an original method for computing the probable size of a polymer in good solution, the Flory-Huggins Solution Theory, and the derivation of the Flory exponent, which helps characterize the movement of polymers in solution.

The Flory convention

In modeling the position vectors of atoms in macromolecules it is often necessary to convert from Cartesian coordinates (x,y,z) to generalized coordinates. The Flory convention for defining the variables involved is usually employed. For an example, a peptide bond can be described by the x,y,z positions of every atom in this bond or the Flory convention can be used. Here one must know the bond lengths l_i, bond angles θ_i, and the dihedral angles ϕ_i. Applying a vector conversion from the Cartesian coordinates to the generalized coordinates will describe the same three-dimensional structure using the Flory convention.

Later years

He accepted a professorship at Stanford University in 1961, became the Jackson-Wood Professor there in 1966 and retired from there in 1975. He was awarded the Nobel Prize in Chemistry in 1974 “for his fundamental achievements, both theoretical and experimental, in the physical chemistry of macromolecules.” He remained active after his retirement, and consulted for IBM for some years. He and his wife Emily Catherine Tabor (now deceased) had three children, Susan, Melinda and John. Susan has two children, Elizabeth and Mary. Elizabeth has three children, Katy Greer, Margaret Greer, and Sam Greer. Paul J Flory died of a heart attack in Big Sur, California in 1985. Melinda has 3 children Susanna, Jeremy and Charles and 3 grandchildren.

He was posthumously inducted into the Alpha Chi Sigma Hall of Fame in 2002.