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Nobel Prize in Chemistry 1974

Paul J. Flory

The Nobel Prize in Chemistry 1974 was awarded to Paul J. Flory *"for his fundamental achievements, both theoretical and experimental, in the physical chemistry of the macromolecules"*.

Information about winners:

Paul J. Flory,

Stanford University, Stanford, CA, USA

RESEARCH INFORMATION:

THE CHEMISTRY OF PLASTICS

This year's Nobel Laureate in Chemistry, Paul J. Flory, has done epoch making research in the field of the physical chemistry of macromolecules. Among the substance which are made up of macromolecules we find our most common plastics - polymers - but also a great number of very important biological compounds, e.g. proteins, nucleic acids, cellulose and rubber. Flory's early research concerned polymers of the nylon type, polystyrene. Their molecules are built up of long chains of atoms and can be compared to strings of beads where the atoms are represented by the beads. These strings can be very

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long and contain thousands of atoms - beads - in the chain. These chains are also very flexible and can assume the most varying shapes. Stretched molecules - chains - are found in fibres such as nylon. In solid plastics the molecules are rolled into balls. In solvents the molecules assume more or less ballshaped structures.

It was very difficult to find a satisfactory theory of how these molecules behaved. On the one hand, the statistical treatment of the shape of chains is very complicated and, on the other hand, it is difficult theoretically to define quantities so that the properties of polymer chains can be compared with different chemical properties.

The Flory temperature

Flory has solved both these problems. He has introduced a new concept, theta temperature and theta point properties. A simplified description is as follows: If a polymer molecule is dissolved in a good solvent agent then the chain is somewhat stretched out as the attraction forces between the chain and the solvent molecules are stronger than those between the different links in the chain. If the temperature is lowered, the solvent agent deteriorates and the attractive forces between the molecules of the solvent agent and the chain become weaker whereas the attraction forces between the links of the chain strengthen. Consequently, the molecules of the chain draw closer together and it decreases in size. It becomes increasingly compact and finally becomes insoluble. There must then exist a certain intermediate temperature - theta temperature - where both these different attraction forces balance each other. At this temperature, now called the Flory temperature, the polymer molecule assumes a kind of ideal state. The Flory temperature varies for different types of polymers and for different solvent agents, but by using their respective Flory temperatures it is possible to make useful comparisons.

Flory has also succeeded in working out quantitative terms describing the extension of polymer chains when the temperature is raised above the Flory temperature. He has demonstrated that the chain in solid polymers has the same extension as it has in polymers in solution at the Flory temperature. This has been of vital importance for the development of polymer chemistry

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Universal constan

Flory has also demonstrated how quantities used in the theory can be determined experimentally by measurements of viscosity, light dispersion, ultra centrifugation and diffusion. By skilful analysis Flory has shown that it is possible to find a universal constant which quantitatively summarizes all the properties of polymer solutions. This constant is now known as Flory's Universal Constant. It can be said to be analogous to the universal gas constant.

Flory has done pioneer research in elucidating the formation of polymer molecules. This takes place by the addition or condensation of small molecules which then link up into long chains. Flory was the first scientist to demonstrate the theoretical connection between the lengths of formed chain molecules and reaction conditions. He also discoverer a very important, entirely new type of reaction, the so-called chain transmission. A growing chain can transmit its growing power to another molecule and itself stop growing.

Has remained in the lea

In recent years Flory has increasingly turned his attention to polymers of biological origin, both in solutions and in gels. He has carried out important studies - both experimental and theoretical - in this field.

During the nearly 40 years Flory has been active as a research scientist the chemistry of macromolecules has developed from what was, theoretically speaking, a primitive discipline, to the highly advanced science of today. This progress has been made thanks to the great achievements of various groups of research scientists at universities and research laboratories. All this time, Flory has remained the leading researcher in this field and this demonstrates his exceptional standing as a scientist. This is largely due to his ability to find essentially simple solutions to fundamental problems. At the same time he has an outstanding ability to extract the necessary experimental findings from well-planned, but often simple experiments, which he carries out with a comparatively small research team.

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http://www.nobelprize.org/nobel_prizes/chemistry/laureates/1974/press.html