The Nobel Prize in Chemistry 1963

Presentation Speech by Professor A.Fredga, Member of the Nobel Committee for Chemistry of the Royal Academy of Sciences

Your Majesties, Royal Highnesses, Ladies and Gentlemen.

Our epoch has witnessed the gradual replacement of traditional materials by synthetics ones. We have all seen that plastics can often substitute glass, porcelain, wood, metals, bones, and horn, the substitutes being frequently lighter, less fragile, and easier to shape and work. It has in fact been said that we live in the Age of Plastics.

Plastics consist of very large molecules or macromolecules often forming long chains of thousands of atoms. They are made by joining together normal size molecules must be reactive, but some outside help is also necessary to make them combine. This outside assistance often used to be supplied by free radicals, added to trigger off the reaction of polymerization. The term "free radical" may conjure up political connotations, and indeed free radicals have much in common with revolutionaries: they are full of energy, difficult to control, and have an unpredictable outcome. Thus, free-radical reactions give polymer chains with branches and other anomalies.

However, Professor Ziegler has found entirely new methods of polymerization. Studying organometallic compounds, he discovered that organoaluminium compounds, which are easy to prepare, are particularly suitable for work on the industrial scale. Peculiar electrical forces operate around an aluminium-carbon bond in a hydrocarbon chain: reactive molecules are drown in and sandwiched between the carbon atom and the aluminium atom, thus increasing the lenght of the chain. All this happens much more quietly than in free-radical reactions. When the chain is long enough, we detach the aluminium and thus stop further growth of the molecule. The combination of aluminium compounds with other metallic compounds gives Ziegler catalysts. These can be used to control polymerizations and to obtain molecular chains of the required length.

However, many systematic experiments - and indeed some accidental findings - were necessary to reach this stage. Ziegler catalysts, now widely used, have simplified and rationalized polymerization processes, and have given us new and better synthetic materials.

The individual molecules strung together to form polymers are often so built that the resulting chain exhibits small side groups or side-chains at certain points, generally one at every other carbon atom. But the picture is more complicated, since these side groups can be oriented either to the left or to the right. When their orientations are randomly distributed, the chain has a spatially irregular configuration.

However, Professor Natta has found that certain types of Ziegler catalysts lead to stereoregular macromolecules, i.e. macromolecules with a spatially uniform structure. In such chains, all the side groups point to the right or to the left, these chains being called isotactic. How is this achieved when the microstructure of the catalyst is probably highly irregular? The secret is that the molecular environment of the metal atom, at which new units are stuck on to the chain as mentioned before, is so shaped that it permits only a definite orientation of the side groups. Isotactic polymers show very interesting characteristics. Thus, while ordinary hydrocarbon chains are zigzag- shaped, isotatic chains form helices with the side groups pointing outwards. Such polymers give rise to novel synthetic products such as fabrics which are light and strong at the same time, and ropes which float on the water, to mention only two examples.

Nature synthesizes many stereoregular polymers, for example cellulose and rubber. This ability as so far been thought to be a monopoly of Nature operating with biocatalysts known as enzymes. But now Professor Natta has broken this monopoly.

Towards the end of his life, Alfred Nobel was thinking of the manufacture of artificial rubber. Since than, many rubber-like materials have been produced, but only the use of Ziegler catalysts enables us to synthesize a substance that is identical with natural rubber.

Professor Ziegler, your excellent work on organometallic compounds has unexpectedly led to new polymerization reactions and thus paved the way for new and highly useful industrial processes. In recognition of your services to Science and Technology, the Royal Academy of Sciences has decided to award you the Nobel Prize. It is my pleasant duty to convey to you the best wishes of the Academy.

Professor Natta, you have succeeded in preparing by a new method macro molecules having a spatially regular structure. The scientific and technical consequences of your discovery are immense and can not even now be fully estimated. The Swedish Royal Academy of Sciences wishes to express its appreciation by awarding you the Nobel Prize. Please accept the best wishes of the Academy. I would also like to express the admiration of the academy for the intensity with which you are continuing your work in the face of difficulties.

Professor Ziegler. In the name of the Academy, I now ask you to accept the Nobel Prize from His Majesty the King.

Professor Natta. In the name of the Academy, I now ask you to accept the Nobel Prize from His Majesty the King.

From Nobel Lectures, Chemistry 1963-1970.

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La cerimonia a Stoccolma
(10 Dicembre 1903)
The ceremony in Stockholm
(10th December, 1963)